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Neuroscience in gambling policy and treatment: an interdisciplinary perspective

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Neuroscientific explanations of gambling disorder can help people make sense of their experiences and guide the development of psychosocial interventions. However, the societal perceptions and implications of these explanations are not always clear or helpful. Two workshops in 2013 and 2014 brought together multidisciplinary researchers aiming to improve the clinical and policy-related effects of neuroscience research on gambling. The workshops revealed that neuroscience can be used to improve identification of the dangers of products used in gambling. Additionally, there was optimism associated with the diagnostic and prognostic uses of neuroscience in problem gambling and the provision of novel tools (eg, virtual reality) to assess the effectiveness of new policy interventions before their implementation. Other messages from these workshops were that neuroscientific models of decision making could provide a strong rationale for precommitment strategies and that interdisciplinary collaborations are needed to reduce the harms of gambling.

Introduction

In DSM-5,[1] gambling disorder (hereafter referred to as problem gambling) is classified in the Addiction and Related Disorders category, within a subcategory of non-substance-related disorders. The reclassification of pathological gambling from an Impulse Control Disorder in DSM-IV was based on growing evidence from empirical observations that behavioural addictions, such as problem gambling, show similarities (including brain processes) to alcohol and other drug addictions.[2,3] Yet, compared with the large research initiatives in drug addiction (eg, the Dutch NEXT study[4] of ecstasy and the US ABCD study[5] of substance addiction), problem gambling remains largely descriptive and poorly integrated, with research often failing to translate into clinical or policy interventions. To address this paucity of research, a multidisciplinary international consortium of 25 gambling and addiction researchers—from neuroscience, economics, public health, and health policy—and clinicians, met at two workshops (called *Problem gambling: an interdisciplinary dialogue between neuroscientists, clinicians and policy makers*) in 2013 and 2014 in Melbourne, Australia. Here, we present the key findings of these two workshops.

Gambling workshop 2013: scoping the field

The first workshop outlined the gambling-related issues faced by scientists, clinicians, and policy makers. According to the Australian Productivity Commission,[6] gambling raises about AUS$19 billion in revenue per year in Australia, 55% of which flows through electronic gaming machines (EGMs) in clubs and hotels. Despite substantial gambling-related harms and associated costs, gambling is estimated to yield a net benefit to the Australian economy of $4–11 billion per year, although these benefits do not take into account secondary costs, such as those associated with suicide, divorce, and loss of social capital.[6] The extremely low prevalence of severe or pathological gambling in Australia (about 0·6%, depending on the jurisdiction)[7] also grossly misrepresents the scale of the problem among people who use EGMs. The prevalence of problem gambling in people who use EGMs in Australia is as high as 15% and high-intensity machines allow losses of up to $12 000 each hour.[6] Although only 0·6% of Australians are thought to be problem gamblers, this group accounts for an estimated 40% of monetary losses on EGMs.[6] Similar patterns are found in most Western countries.[8]

Clinical outcomes are adversely affected by stigma and shame around problem gambling in the community and workplace. Treatment seeking for gambling among individuals with gambling disorders is low (<10%[9]), and is lower than for substance use disorders and other mental-health disorders.[10] Similar to other drug addictions,[11] natural recovery is common: most affected individuals follow a transitory, episodic pattern of gambling, rather than an enduring and chronic pattern.[12] It is unclear whether the repeated-episodes pattern of problem gambling is due to the natural course of the underlying addictive process or to external constraints on continued excessive gambling that emerge as problem gamblers deplete their financial resources and access to credit. The process of treatment-

***Panel:* Key conclusions from the 2013 and 2014 workshops**

- Neuroscience might aid the development of safer gambling products
- Neuroscience shows how electronic gaming machines are particularly addictive commodities that need careful regulation
- Industry involvement in research needs urgent attention (eg, funding guidelines)
- Interdisciplinarity is crucial to the design and interpretation of studies
- Studies must include problem gamblers who do not fulfill diagnostic criteria but suffer substantial harms

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assisted recovery is similar to other addictions in that problem gamblers rely on several approaches to overcome their condition. Psychotherapies (ie, cognitive behavioural therapy or brief interventions) are moderately effective for the treatment of problem gambling, and pharmacological treatments (eg, naltrexone, naloxone, and nalmefene) have shown some effectiveness.[8,13] Further research is required to uncover the neurobiological mechanisms that sustain excessive gambling and how these mechanisms might be interrupted by various treatment methods to determine how to prevent problem gambling and deliver the most effective services.

Implications of neuroscience for treatment

Problem gambling is associated with several cognitive impairments, including diminished reward sensitivity (associated with reduced activity in the reward circuits), reduced ability to delay reward or learn from negative consequences, stronger physiological responses to near wins, and poor error monitoring.[14] Furthermore, co-occurring and chronic substance use might exacerbate cognitive impairments associated with problem gambling and complicate treatment and recovery. At the workshop we recognised the neuropsychological effect of near wins on the development and maintenance of gambling addiction as a key feature of problem gambling. Modern EGMs are carefully engineered to give players an illusory sense of control over reinforcement rates despite fixed payback percentages, and the type of players who are the most susceptible to acquiring the habit of excessive gambling are also those who are the most sensitive to such design elements.[15] The limitations of neuroscience research in gambling include the presence of conflicting findings that are often ignored—a major concern given the prevalence of false positives.[16,17] Increased impulsivity in problem gamblers seeking treatment versus problem gamblers in the general community might explain some of the variation in research findings[18,19] and warrants further investigation (eg, treatment-seeking *vs* non-treatment-seeking or relapsing *vs* non-relapsing problem gamblers).[20] Views on the clinical and policy implications of this research were similarly cautious.

We regarded treatment matching with biomarkers as premature, with further evidence from clinical trials needed.[21,22] The identification of gambling subtypes (ie, mild, moderate, severe, or pathways models[23]) was deemed a promising area of investigation, which might yield better treatment outcomes. Optimism was held for treatments emerging from neuroscience research, particularly those that exploit targeted cognitive therapies, such as neurostimulation or neurofeedback.[24] Neuroscience might also provide novel tools (eg, virtual reality) to assess the effectiveness of new clinical or policy interventions before their implementation or allow the evidence-based development of less harmful gambling products (eg, less harmful EGMs).

Implications of neuroscience for policy

The inclusion of problem gambling disorders as a behavioural addiction in DSM-5 was controversial. The effect of ratifying gambling disorder as an addiction on most insurance policies remains unclear. For example, the Affordable Health Care and Mental Health Parity and Addiction Equity Acts ensure that all US citizens receive the same level of benefits for mental or substance-use treatment as for traditional medical services. It is unclear whether the reclassification of gambling within the category of Addiction and Related Disorders will ensure that people with gambling disorders are covered by the increased medical insurance coverage in the USA.

Characterisation of gambling as an addiction also affects research. As workshop participants pointed out, neurobiological studies of problem gambling could focus on the addictive properties of the machines. Although the precise level of addictiveness of EGMs is debated in the scientific literature,[25] there was widespread consensus at the workshops that EGMs represent the most harmful and dangerous form of gambling activity. The practice of programming high numbers of near wins into EGMs was banned in the USA in 1989 following the presentation of findings from psychosocial research to the Nevada Gaming Commission in 1988.[26] We viewed modification of the characteristics of gambling products as being an effective and efficient way for reducing gambling-related harm—for example, the highly addictive elements of EGMs could be dampened to make less addictive and safer EGMs (eg, less frequent near wins, visual reminders of the money and time spent on a machine, or limits on total losses). Modifying the characteristics of gambling products to reduce gambling-related harm would require governments with the regulatory willpower to compel industry to make such changes.

A major challenge for policy makers is that benefits and harms are not objective and require consideration of moral qualities, such as justice and respect for persons. Gambling is a regressive form of resource redistribution that tends to extract the greatest resources and cause the greatest harm in socially disadvantaged areas, which is where EGMs are most concentrated.[6] Effective policy should support a sustainable gambling industry to maximise benefits, including personal enjoyment, while minimising harms.

Policy must also be practical and achievable, which requires the balancing of pragmatic concerns, including the role or influence of vested interests such as industry and government. Although it is common not to accept industry contributions to alcohol and tobacco research, this practice is not seen for gambling research.[27] Gambling research receives minimal government support and is often funded through taxes on the proceeds of gambling. Acknowledging that industry funding can bias research, we could not reach a consensus about the appropriateness of receiving industry contributions for the support of gambling

research or treatment. This discussion was continued outside of the workshops and led to a paper.[27]

Greater transparency and guidance is needed about when and how it might be permissible to accept industry funding. Such guidance might include development of research funding guidelines that receive widespread support, as has occurred in other areas of addiction research.[28,29] More research is needed to determine the best strategies for policy implementation because of the inherent difficulties in identifying whose responsibility it is to implement policy. Moreover, potential conflicting interests pervade the policy-implementation landscape. Two areas in which policy change could be made quickly and easily, providing that there is the necessary political will, are addressing the advertisement of gambling products and making the process for appealing gaming licences more accessible and transparent.

Gambling workshop 2014: key challenges

The 2014 workshop explored in greater detail three key topics that were identified in the 2013 workshop: the neuroscience of EGMs, the utility of subtyping to improve clinical treatment, and precommitment policy interventions. The aim was to understand how best to implement change in these areas.

Neuroscience of EGMs

We regarded EGMs as the source of the greatest harm in gambling, a view that was supported by both clinical and epidemiological evidence.[25,30,31] EGMs have a sophisticated design in terms of the game and environmental settings that keep people using them.[32] Research to examine the characteristics of modern EGMs and how they exploit human cognitive properties is needed. Various features of EGMs elicit gambling-related cognitive distortions that perpetuate gambling, including traditional near-win (or near-miss) outcomes[33] and, on modern multiline slot machines, "loss disguised as a win" (ie, when the amount won is less than the spin wager, but the event is accompanied by reinforcing sights and sounds similar to a win).[34] Studies that used psychophysiology (skin conductance, heart rate) and neuroimaging techniques found that these game events (near wins and loss disguised as a win) activate the sympathetic nervous system and recruit reward-related neural circuitry,[35,36] and that these responses were amplified in participants with problem gambling.[37]

Pathological decision making can emerge from a dysregulated executive system, which can be difficult to alter. For instance, individuals often interpret near wins as evidence that they are mastering the game, which in turn fosters an illusion of control.[38] Losses disguised as wins are particularly pernicious because they undermine the decision-making capacity of individuals who are already experiencing cognitive distortions and thereby impair their ability to make rational choices.[34,39] A general consensus of the workshop was that losses disguised as wins are an area in which policy makers in most jurisdictions could easily and quickly make changes to the regulations that determine how EGMs operate. It was also noted that it should not be necessary to rely on neuroscientific explanations because of robust behavioural data showing that losses disguised as wins undermine the decision-making capacity of the gambler.

A potential advantage of research about the neuroscience of EGMs was increased focus on the machine or gambling activity as both a target of much needed policy intervention and a priority for additional research. The neuroscience of decision making and the sophisticated engineering of EGMs to exploit the poor decision making of gamblers might provide an important motivation for governments and policy makers to address the highly addictive nature of EGMs. Some participants, however, raised concerns that neuroscience, particularly the brain-disease model of gambling, might focus attention on the individual gambler and deflect attention from addressing agents of gambling addiction (eg, EGMs).[40]

Although we have a greater understanding of why EGMs are dangerous, questions remain: how do we address the harmfulness of these machines? Do we ask governments to legislate to remove the harmful elements from the machines, and if so which ones? Or, do we simply require manufacturers to include prominent warning messages on the machines that state that they are harmful?

Validity and utility of subtyping to improve clinical treatment

The treatment of problem gambling is complicated by substantial heterogeneity, much of which is due to high rates of comorbidity with other psychiatric disorders. Several theoretical typologies of problem gambling, such as the pathways model[23] and the clinical typology proposed by Dannon and colleagues,[41] have tried to account for this heterogeneity. The pathways model includes three subpopulations: behaviourally conditioned problem gamblers; emotionally vulnerable problem gamblers; and antisocial, impulsive problem gamblers. The recognition of subpopulations of problem gamblers might help advance our understanding of the aetiology and course of problem gambling, facilitate the study of genetic and neurobiological mechanisms, and allow for investigation of differential responsiveness to treatment. Although the pathways model[42,43] outlines a strong convergent validity for the three subtypes, subtyping remains a promising theory and the focus of important scientific research. We concluded that the available evidence does not support the routine use of subtyping in clinical practice.

We felt the greatest challenge to gambling treatment is getting and keeping individuals in treatment. Although intensive interventions can be more effective than brief interventions (ie, <10 min), even brief or online interventions can substantially reduce the severity of

problem gambling.[44] We believe that greater emphasis on low-cost, non-intensive interventions is needed, with more intensive interventions reserved for those who do not respond to the less intensive approaches.

Precommitment policy interventions

Precommitment interventions that enable gamblers to adhere to their self-imposed limits have received substantial attention worldwide.[45] Various precommitment models (eg, full, partial, mandatory, voluntary, or hybrid) with different features (eg, spend or time limits) have been proposed. These models are typically based on behavioural economic theories, such as dual-process models of cognition.[46] Such models postulate that decision making is a function of both experiential and affective processes (intuitive system) and analytical and deliberative processes (rational system). Impulsive behaviour emerges when the intuitive system dominates decision making, which is often triggered by arousal after exposure to situational cues (eg, in gambling venues). In this framework, precommitment strategies enable problem gamblers to adhere to rational decisions made at times of low arousal and to avoid being overwhelmed by increased cognitive and emotional arousal while gambling that can lead them to focus on immediate reward at the expense of longer-term goals. Unfortunately, research about precommitment is often undermined by poor study design, such as inadequate study duration or politically driven changes in trial implementation,[47] as occurred in the abandonment of a trial of mandatory precommitment in Australia.[48] Therefore, substantial uncertainty about the efficacy of various precommitment strategies remains. Evidence from decision neuroscience[49,50] casts doubt on the validity of dual-process models, on which pre-commitment mechanisms are based, and has suggested that current interventions might need to be reconsidered. Attributing problem gambling solely to a breakdown of impulse control, as the dual-process model suggests, is misleading because it ignores other, more potent aspects of the disorder, including compulsivity and learning deficiencies.[14,36,37,39]

Promises and pitfalls of neuroscience research on gambling

Neuroscience may provide new methods to identify people at increased risk of developing a gambling disorder, new targeted treatments, or better methods to match problem gamblers to treatments. However, caution is needed to ensure that the search for neurobiological targets does not divert attention from the social drivers of gambling or population-based approaches to the prevention of gambling-related harm. We should also avoid an exclusive focus on the individual problem gambler at the expense of gambling products as possible targets for intervention.

There was broad agreement that the most promising focus for neuroscience research was to further our understanding of how EGMs work and help to design machines and policies on EGMs that minimise harms. Suggestions included use of neuroscience to develop less harmful or reinforcing machines and provision of rating scales to assess the harmfulness of different gambling products.

A major impediment to gambling research is poor access to industry products and data. Epidemiological data about the prevalence of gambling and amount of money lost over periods of time and by whom are essential for the development of effective policies to reduce gambling-associated harm. Governments could require the gambling industry to collect and provide data on the gambling incomes of licensed venues to government agencies, which could be used in scientific research. Access to data about EGM characteristics (ie, game type, reinforcement schedule) would enable researchers to determine how different characteristics are related to gambling behaviour and how changing certain aspects of EGMs would alter problematic gambling behaviours.

Neuroscience has been seen by government officials and policy makers to provide a strong rationale for precommitment strategies[45] by acknowledging the effect that increased cognitive and emotional arousal during gambling can have on overriding rational decisions about long-term goals. Neuroscience might be used to argue that gambling products, especially EGMs, are not an ordinary commodity and that their use should be carefully regulated similar to other addictive products (eg, alcohol and tobacco).

Neurobiological explanations of mental illness have been shown to have substantial and often adverse effects on the attitudes that clinicians and members of the general public have towards people with an addiction.[51,52] In the absence of public understanding that the brain is plastic and malleable, especially with abstinence,[53] such explanations could increase stigma by suggesting that problem gamblers are unable to control their behaviour as a result of it being hardwired in their brains.[54] Future research will need to address the social effects of neuroscience on public understanding of problem gambling.

Use of neuroscience to influence policy

A crucial question is how we can ensure that our research findings are heard and acted on by policy makers in relevant topics (eg, machine design, definition of safer gambling, venue environment, and person—environment interaction). To enact change, research must produce results that can be acted on in a timely manner and have clear links to recommended outcomes. Researchers should also consider multiple methods of disseminating findings to increase the likelihood that they are seen and understood by policy makers.

Gambling disorder is highly comorbid with other mental illnesses, yet it is often left out of treatment-related and other research about addiction and mental

health. Thus, there is an urgent need to link gambling research and treatment with other areas (eg, alcohol, mental health) and incorporate its questions into large longitudinal studies.

Researchers need to broaden the definition of harm to include gamblers at low and moderate risk of harm, because this is the population on which we can have the greatest effect and which includes individuals who might go on to become more severely disordered gamblers. Broadening awareness of the scale of the gambling problem is essential, if we are to demonstrate to policy makers the importance of the issue and the extent of social harm that problem gambling causes.

It is also important to determine what constitutes sufficient evidence for enacting policy change. Researchers need to educate and inform policy makers about the various levels of scientific evidence and the characteristics of good-quality research. Researchers are best placed to provide the most comprehensive overview of current evidence, which might balance the messages and viewpoints that policy makers receive from more vested interests (eg, industry). However, researchers must clearly articulate this evidence in short, easily digestible, briefing documents.

Conclusions

Insights from neuroscience can help clinicians and patients make sense of gambling disorder and take steps to reduce or eliminate harmful gambling behaviours, while also providing a rationale for psychosocial interventions. However, clear evidence of the effect that messages based on neurobiological research have on the behaviour of problem gamblers and the wider society is scarce. More research is needed to examine at whom neurobiologically informed messages should be aimed and how they should be delivered. Although neuroscience has shown that disordered gamblers have cognitive impairments, gambling behaviour is also driven by environmental and emotional cues, which should be addressed as well.

A recurring theme of the workshops was the need for an explicit definition of the overarching aim or philosophy when addressing gambling. The language used to describe this goal can be instructive. Stakeholders often use the phrase responsible gambling, but many stakeholders have different concepts of who is responsible and what responsible gambling entails. Responsibility might refer to corporate responsibility, such as responsibility of the venue or industry to provide safe gambling environments and products. By contrast, the industry stresses the role of the individual in gambling responsibly. Neuroscience can be used to focus attention on the minority of individuals at increased risk of developing problem gambling (the industry-supported view) or on the dangers of products used in gambling. Neuroscience researchers need to ensure that the industry-driven view does not predominate.

A consistent message from these workshops was the need for interdisciplinary collaborations to reduce the harms of gambling and ensure that researchers ask appropriate questions. Interdisciplinary collaborations broaden our understanding of the issues involved in addressing gambling and improve our interpretation and design of scientific studies. Interdisciplinarity is also necessary to manage complex data sets that require a wide range of research skills. This message should be heeded by researchers, clinicians, and funding agencies. In the meantime, we will continue to bring this consortium together and link it to the biannual Victorian Responsible Gambling Foundation national conference to grow this interdisciplinary capacity and cohesion.

Contributors

MY, WH, and AC conceived and organised the workshops, with intellectual input from VL, GY, CM, ARA, and LP. MY, WH, and AC wrote the first draft of the manuscript. All authors assisted in drafting and revision of the manuscript. All authors have approved the final manuscript.

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